The Sound of Music

Pitch
- Related to frequency
- Higher frequency = higher pitch

Loudness
- Related to amplitude
- Larger amplitude = louder sound

Timbre
- quality of sound
- Depends on natural frequencies of sound waves produced by an object
- Most sounds are made up of a number of frequencies; sound quality depends on relative intensities of these frequencies

Beat
- Oscillations of wave amplitude (sum of amplitudes of different frequency waves: this sum oscillates in

intensity). A listener hears pulsing variations in loudness

Music Vs. Noise

- Some objects tend to vibrate at a single frequency and produce a 'pure' tone (e.g. flute)
- Some objects vibrate and produce more complex waves with a set of frequencies that have whole number mathematical relationships, producing a 'rich' tone (e.g. tuba)
- Some objects vibrate at a set of multiple frequencies that have no simple mathematical relationship between them. This produces 'noise'. (e.g. dropping a meter stick on the floor)

Vocal chords

- Two membranes in the throat
- Air from lungs vibrates vocal chords

- Frequency controlled by muscular tension
- Amplitude controlled by amount of air (lungs)

Instrument	Vibrating Part
Brass tuba, trumpet, trombone	air column
Strings guitar, piano, violin	String
Reed saxophone, clarinet	Reed → air column
Singers Voice	vocal chords

Natural frequency (resonant frequency)
- Frequency/frequencies at which an object tends to vibrate when disturbed
- Depends on properties of object

How do we change the sound a guitar makes?
How do we change the sound a tuba makes?

Forced vibration and amplifying

- A louder sound is always produced when an accompanying object of greater surface area is forced into vibration at the same natural frequency

RESONANCE DEMO

Resonance

- When one object vibrating at the same natural frequency of a second object forces that second object into vibrational motion
- When an object is forced into resonance vibrations at one of its natural frequencies, it vibrates in a manner such that a standing wave is formed within the object

Standing waves

- Vibrational pattern created within a medium when the vibrational frequency of a sources causes reflected waves from one end to interfere with incident waves from the source
- Such patterns are only created within the medium at specific frequencies: these frequencies are

known as **harmonics**

https://www.youtube.com/watch?v=X8qZO6g_X5Q

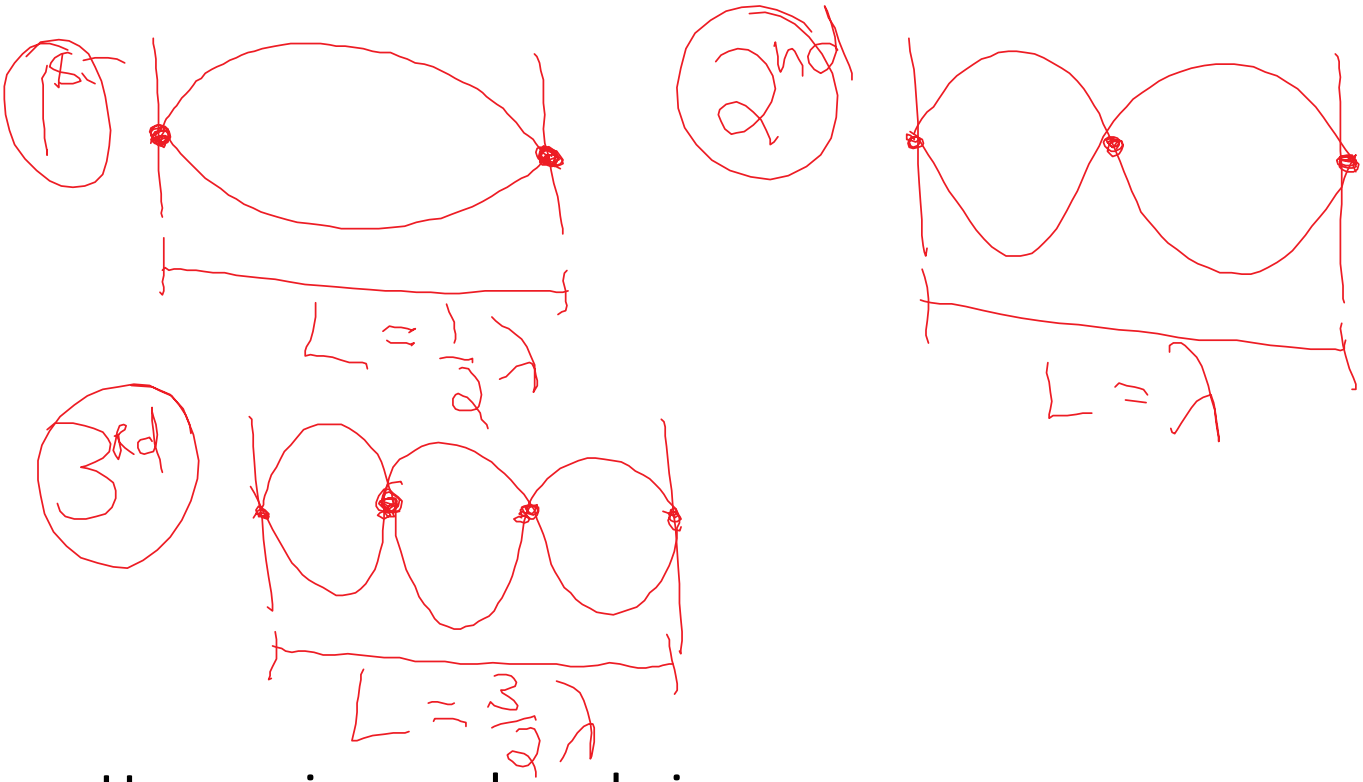
CHLADNI PLATES VIDEO

https://www.youtube.com/watch?v=lRFysSAxWxI

HARMONICS

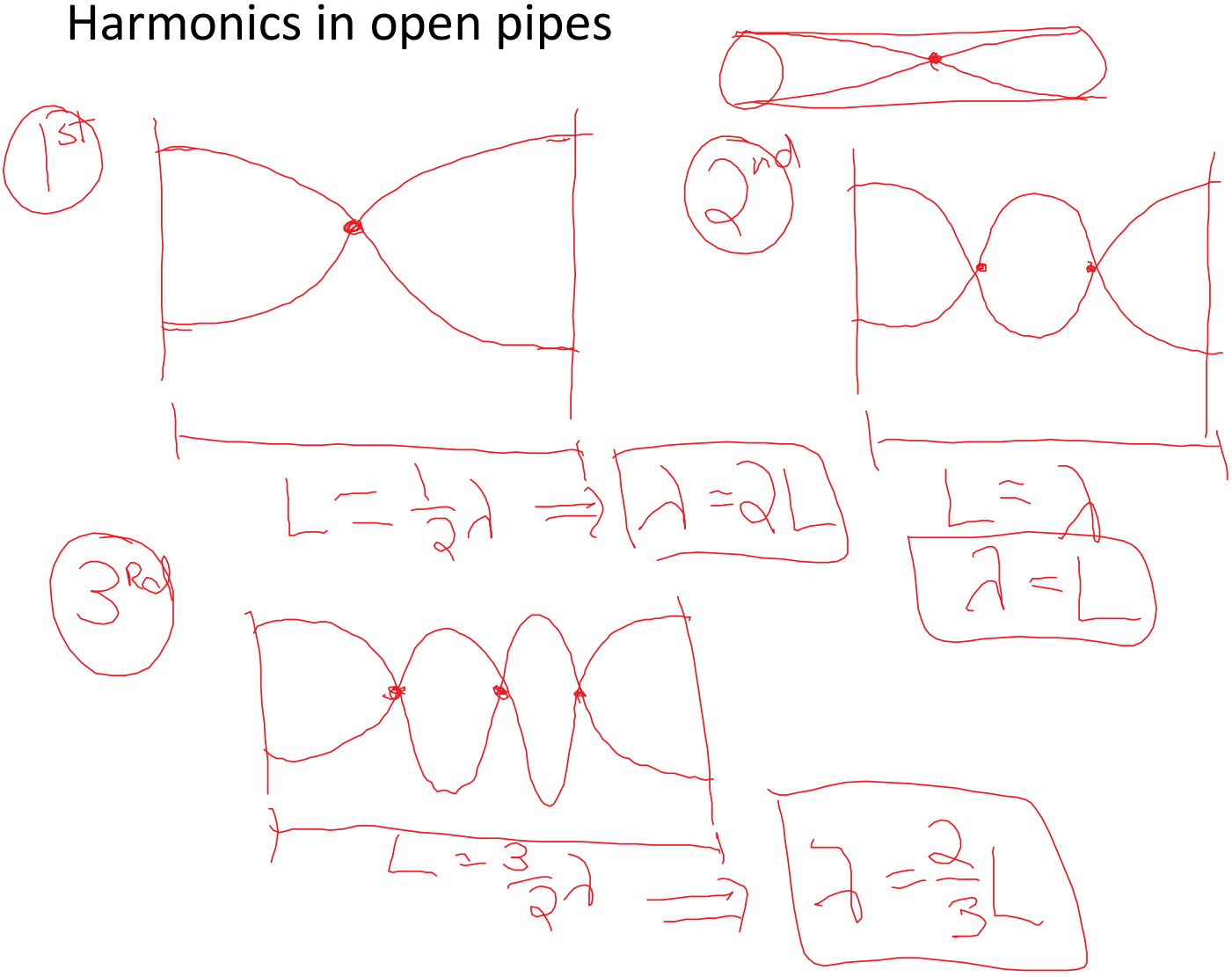
$V = \lambda f$

Harmonics in guitar strings



Harmonics on closed pipes

Harmonics in open pipes



- At any frequency other than a harmonic frequency, the resulting disturbance of the medium is irregular and non repeating

Fundamental Frequency = first harmonic

- Lowest frequency produced by a musical

instrument

- Each harmonic is a whole number multiple of the fundamental frequency